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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : B60Q 1/34, 1/38	A1	(11) International Publication Number: WO 87/03548 (43) International Publication Date: 18 June 1987 (18.06.87)

(21) International Application Number: PCT/AU86/00380

(22) International Filing Date: 11 December 1986 (11.12.86)

(31) Priority Application Number: PH 3828

(32) Priority Date: 11 December 1985 (11.12.85)

(33) Priority Country: AU

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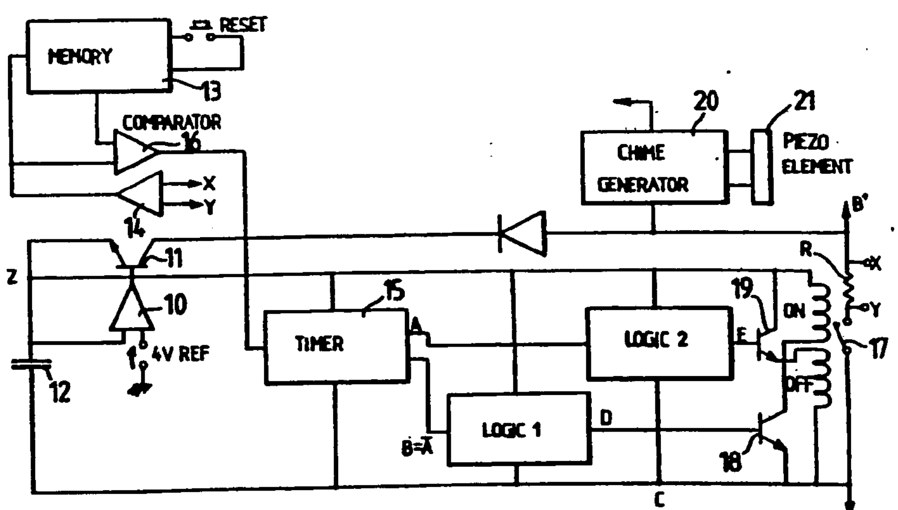
(81) Designated States: AT (European patent), AU, BE (European patent), BR, CH (European patent), DE (European patent), DK, FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE (European patent), SU, US.

Published
With international search report.

(54) Title: ADAPTIVE SWITCHING CIRCUIT

(57) Abstract



LOGIC 1

B	C	D
0	0	0
0	1	0
1	0	1
1	1	0

LOGIC 2

A	C	E
0	0	0
0	1	0
1	0	0
1	1	1

An adaptive switching circuit for switching electrical power to a load, such as turn indicator lamps in a motor vehicle. The switching circuit comprises load switching means (17, T3) for conducting electrical power to the load upon actuation and timing means (15, 23) for intermittently actuating the load switching means. The switching circuit includes measuring means (14, 23) for measuring a value of electrical current associated with the power and memory means (13, 35) for storing at least one value of electrical current. The switching circuit also includes comparator means (16, 23) for comparing the stored value of current with the measured value and means for indicating whenever the stored value of current differs from the measured value by a predetermined amount. The stored value of electrical current may be an averaged or normalized representation of the value of electrical current. The averaged or n rmalized representation of current may be calculated by reference to the voltage associated with the electrical power.

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"ADAPTIVE SWITCHING CIRCUIT"

The present invention relates to switching circuits for intermittently switching power to a load. In particular the present invention relates to switching circuits which adapt to the environment to which they are fitted. The invention has been particularly developed for use in vehicles and, in particular, as a flasher unit for intermittently switching power to the turn indicator lamps or hazard warning indicator lamps, which constitute the load, although invention is not limited to this particular field of use.

The adaptive nature of the switching circuit may enable it to be fitted 'universally' to a variety of vehicles and/or environments. The switching circuit may be adapted to 'learn' the characteristics of the vehicle or environment to which it is fitted, and as well as performing its prime switching function, may provide indication that some part of its load eg a lamp, has failed.

In a vehicle, the switching circuit may adapt to the vehicles turning indicator system, eg. if a trailer is fitted, the circuit may recognise this change i.e. 'adapt' to it, so that it will still provide lamp failure (hereinafter referred to as outage) indication should it occur.

An object of the present invention is to provide a switching circuit of the aforementioned kind which may be used with a wide range of operating voltages and loads.

In the past, flashers used in vehicles for intermittently supplying power to the lamps have been arranged to drive contacts in the lamp circuit either electromechanically or electronically. The electromechanical arrangement has used, for example, relays such as twin coil relays with capacitors arranged across the relays. Both the electromechanical and electronic driving circuits for the contacts have been designed to operate as desired when the load and supply voltage are both constant and known. However once there was variation in load or supply voltage the flasher circuit would not operate as desired.

A significant drawback of prior art flashers is that

they are generally voltage and load d pendent. Accordingly it has not hitherto been possible to provid a "universal" flasher unit, i.e. one capable of operation in various operating environments such as in vehicles having 6 volt, 12 volt and 24 volt systems or under varying load conditions such as when a trailer or caravan is connected to the vehicle.

The switching circuit of the present invention includes load switching means. The load switching means is adapted to switch current (power) to a load connected to the switching circuit. The load may comprise one or more filament lamps. The load switching means may be provided in any suitable form. In one form the load switching means may comprise a latching, non-latching or partially latching relay.

An advantage of a latching relay is that it avoids the need for a relatively large energy storage capacitor, to provide hold-in current for the flash "on" duration which would be required for a non-latching relay. With a magnetically latched relay, the capacitor, or similar energy storage means, only needs sufficient energy to power electronics as required and the "off" coil of the latching relay.

Problems associated with use of latching relays include a non-recoverable state which can exist when the relay is closed and the storage capacitor is fully or partially discharged so that it has insufficient energy to reverse the relay state. Also mechanical shock may put the relay into its "on" position making subsequent operation of a two terminal flasher unit impossible.

Under normal operation, it is possible to avoid closure of the relay until sufficient energy is held in the storage capacitor to ensure the relay can be reopened when required. It is preferably to use relatively high shock resistance rated relays (say, more than 20G) to minimize risk of accidental closure after installation in a vehicle.

A partially latching relay may also be used. Such a relay requires a hold-in current, of much lower value than required with a conventional relay. As with the latching relay, a current pulse to re-open the relay would still be required for normal operations, but this would be less than

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for a fully bistable latching relay.

Preferably the load switching means comprises an FET device and associated drive transistors. In a preferred embodiment, the load switching means may comprise a Metal Oxide Silicon Field Effect Transistor (MOSFET). Two or more transistors may be used if sufficient load current cannot be carried satisfactorily by one device. The MOSFET device requires minimal energy to switch from one state to its other and is ideally suited to this application. MOSFET devices may include integral load current sensing means which may be very gainfully used in this application.

MOSFET devices may switch relatively large in rush currents as can occur with turning on filament lamps. However, to control severe or accidental overload currents, voltage sensing across the MOSFET device can be used to turn "off" the MOSFET device until the current has diminished to a lessened value. At this time the MOSFET may again be turned "on". Of course, if the excessive load is still apparent, the device may again turn "off" and this sequence repeated until stopped by other intervention, eg, a fuse "blowing".

The present invention includes measuring means. In one form the measuring means may be adapted to measure load current (load switch closed) and no load supply voltage (load switch open). The measuring means preferably comprises an analogue to digital (A to D) converter. The measuring means may include one or more sensing resistors and scaling amplifiers associated with the A to D converter. The sensing means may utilize multiplexing switches for selecting various measuring modes. The latter preferably comprises solid state analogue switches.

The A to D converter preferably has sufficient accuracy consistent with further processing of the measured data. In one form a six bit A to D converter may be used. The A to D converter may include automatic zeroing. Auto zeroing is preferred because it may reduce manufacturing requirements. Auto zeroing preferably is performed with load switch "off".

Multiplexing of outputs from the current sense resistor during load switch "on", voltage sense during load

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switch "off" and "auto-zeroing" may be performed by analogue switches.

In one form maximum load current to be measured by the A to D converter may be about 10 Amperes. It is envisaged that a current exceeding 10 Amperes is only likely to occur during "hazard" signalling conditions during which outage detection is not necessary. Limiting the range of maximum load current to be measured will assist in reducing the accuracy necessary (hence the number of bits required) for the A to D converter.

The present invention includes memory means. The memory means may be adapted to store inter alia load current drawn by the load connected to the switching circuit. This may be a measure of the number of lamps connected in parallel. The memory means may be updated when the load current increases. Load current may increase eg. when

i) a trailer or caravan is added to a vehicle for towing;

ii) the hazard lights are turned on;

iii) the switching circuit is first installed or reinstalled in a vehicle.

The memory means may be updated when the load current decreases by a predetermined amount. This may occur eg. when the trailer or caravan is disconnected or hazard lights are turned off. The load current decrease preferably is predetermined such that a load current decrease due to outage may still be detected. In one form the load current decrease may be predetermined to lie in a current range equivalent to between 0.5 - 1.5 (20w) lamps. If the load current decrease falls outside of the predetermined range the memory means may be updated to the lower value.

Additional if the load drop detected is greater than that expected for about 1.5 20 watt lamps, outage preferably is not indicated and the memory is again updated to the new (lower) value. This may prevent unwanted outage indication when hazard lights are turned off (because there are always 2 or more lamps each side of the vehicle) or when a trailer with more than one lamp per side is disconnected.

The memory means preferably is non-volatile. This

is desirable to enable it to store data during extended periods when no power is available. The memory means may comprise an Electrically Erasable Progammable Read Only Memory (EEPROM).

The memory means may be adapted to store load current values measured by the A to D converter. The load current preferably is averaged or normalized before storage. The memory means preferably is updated whenever the stored value differs from the normalized and averaged value.

The memory means may additionally be adapted to store outage status. The latter may be useful if a lamp has failed just before the turn indicator is switched off i.e. near the end of a previous turn indication. This may be indicated as a failed lamp immediately the next time the indicators are operated rather than having to execute a number of cycles before sensing the failed lamp. This may be a beneficial safety feature.

In one form seven bits of non-volatile electrically erasable progammable memory may be used. Six bits may provide sufficient resolution for lamp failure indication and one bit for outage status. More or less bits may be used as deemed necessary for altered or alternative requirements.

The present invention includes timing means. The timing means may be adapted to generate timing pulses having any convenient frequency. The frequency preferably is adjustable. In one form the timing means may generate between 60 - 120 flashes per minute. The duty cycle may be selectable between 40-60% "on" time. In one form outage may be indicated by doubling the flash rate.

The present invention includes comparator means. The comparator means may be provided in any suitable manner and by any suitable means. The comparator means may be adapted to compare the current or power levels sensed by the measuring means with the stored contents of the memory means. The comparator means may include threshold means for determining whether a particular fall in detected load current corresponds to lamp failure (outage). In one form the decision window for indicating outage may range between 0.5-1.5 (20w) lamps.

The pr sent inv ntion includes audible signal generator means. The audible signal generator means may be adapted to generate a distinctive click, chime or other appropriate sound. The audible signal preferably is synchronized with load switching. The audible signal may be adjustable when the switching circuit is installed in a vehicle. The audible signal generator means may include tone generation means and electric to acoustic energy conversion means. In one form the energy conversion means comprise a piezo-electric transducer. The energy conversion means may be driven by the tone generation means.

The audible signal produced preferably comprises a number of different tones, with or without amplitude modulation, to convey a distinctive but pleasant and unique sound to the flasher unit of the present invention. To conserve energy the sound generator preferably is powered only when the turn indicator lamps are off (and the turn indicator switch on of course).

The present invention includes power supply means. The power supply means may include a power supply regulator and a storage element. The power supply regulator is adapted to provide the requisite steady and safe electrical supply for the components of the switching circuit. The power supply regulator means may comprise a voltage regulator.

The storage element is adapted to provide a supply of electrical energy to the switching circuit when the load switch is closed. Several components of the switching circuit which serve no function during this time may be "powered down" to minimize energy storage requirements. The storage element may comprise a storage capacitor. The storage capacitor may be charged via the power supply regulator.

The power supply means may include isolation means for isolating the storage capacitor from the power supply regulator during the load switch "on" period. This may enable the storage capacitor to store requisite energy and voltage during this period. The power supply regulator may be adapted to recharge the storage capacitor during the load switch "off" period. During the load switch "off" period, the power supply regulator may supply other component parts of the switching

circuit, which were powered down during the "on" period.

The present invention includes processing means. The processing means may be adapted to control operation of the switching circuit of the present invention. The processing means may be adapted to provide inter alia means necessary for determining control algorithms, memory utilisation, measurement sequences, measurement and load switch actuation, mathematical procedures and comparisons, power supply operation and overload protection (if required) for the load switch or other components.

In one form the processing means may comprise a microprocessor. The microprocessor may be provided as a custom or semi-custom designed and built electronic microprocessor or microcontroller. The processing means may include integral or associated components for program and data storage.

The processing means may incorporate some or all of the functions of the timing means, comparator means measuring means and audible signal generator means. In other words the custom designed microprocessor may include analogue components integrated on the same silicon chip, i.e. the A to D converter and solid state switches for multiplexing the analogue inputs and auto-zeroing, audible tone generator and possibly overload sense components for the MOSFET (or other) load switch.

This may permit at low cost, implementation of a sophisticated, adaptive, almost universally applicable flasher unit suitable for most vehicles. Further as a consequence of the microprocessor, or similar means, sophisticated automatic adaptation features may be readily implemented.

The processing means may be adapted to perform several functions, although its fundamental task is to time flasher lamp switching at a desired flash rate. Closing the relay, or turning "on" the MOSFET load switch, preferably is not performed unless sufficient energy is stored in the storage capacitor to complete the "on" cycle successfully.

Once each flash cycle, preferably during the indicator lamps "off" period, the proc ssing means may enable the audible signal generator means. Other than these tasks, the processing means may be preoccupied with the detection and

indication of lamp failures. In one form outage may be indicated whenever load current drops by an amount equivalent to that expected for 0.5 to 1.5, 20 watt lamps.

The processing means may be adapted to recalculate average load conditions every flash cycle, provided load deviation is not "significant". If a large increase or decrease of current is detected, e.g. following "hazard" lights being switched on or off, a new averaged and normalized value may be calculated and may replace the stored value after several cycles (say four) have been completed. This is to prevent false indication of lamp failings. This could occur for example, following a return to normal turn indication conditions after switching on hazard lights for one or two cycles. By tracking average load conditions, the switching circuit may be more tolerant of component variations, temperature effects, etc.

If the current increase is beyond a nominally set 10 Amperes maximum then the increased value may not be stored as its value suggests the hazard lights are on (or there is an abnormality). In this instance, the "old" value may be retained until the sensed and averaged current decreases below the set maximum limit. These features may reduce the number of write cycles that may have to be performed by the memory means.

The processing means may be adapted to perform "normalisation" of measured load current. The normalisation process may compensate for effects of varying vehicle supply voltage. For example, a 22 watt lamp in a 12 volt system could draw about 1.98 Amperes at 14 volts, and 1.62 Amperes at 10 volts. Thus, a load with several lamps could vary by more than a failure to be detected due to voltage change alone. The normalisation process preferably adjusts all measured load current values to an equivalent value estimated for a common nominal voltage. This requires the processing means to "know" an approximation of typical voltage to current relationships for indicator lamps.

B fore the processing means can estimate load variation in terms of lamps numbers, it must first decide what nominal system voltage the vehicle uses, i.e. 6, 12 or 24 volts. Based on this information, it may choose a suitable

tol ranc by which the load may deviate from the average, before being recognised as "abnormal" and determining appropriat action.

The processing means may carry out an "auto-zero" function for the A to D converter. This may allow voltages across the load current sense resistor to be accurately measured. The auto-zero function may provide tolerance to long term stability and temperature problems. It may also allow the use of lower precision, simpler and thus generally cheaper components.

Recovery from outage may be provided by the following methods for example. The hazard lights, if available, may be switched on for a few flash cycles and then turned off. This may result in the load value stored in memory being adjusted up (and subsequently down) without outage indication as discussed previously.

The switching circuit may update the stored load current value after the circuit has been left operating continually for longer than three minutes. (This "reset" action preferably is set longer than is expected to occur during normal vehicle turn operation). A further recovery method may involve inclusion of a "learn" or reset input to the switching circuit. This may require provision of another input and is not preferred.

The recovery methods described above may require education of the user via the installation and operating instructions provided with a flasher unit. This requirement is seen to be more than compensated for by the flasher unit's special features, e.g. no other standard flasher unit currently available is able to indicate lamp failure while a trailer is connected.

According to one aspect of the present invention there is provided a switching circuit for switching electrical power to a load, said circuit comprising:

load switching means for conducting said power to said load upon actuation;

timing means for intermittently actuating said load switching means;

measuring means for measuring a valu of electrical

current associat d with said pow r;

memory means for storing at least one said value of electrical current;

comparator means for comparing said stored value of current with said measured value; and

means for indicating whenever said stored value of current differs from said measured value by a predetermined amount.

According to a further aspect of the present invention there is provided an automotive flasher unit for intermittently switching electrical power to a plurality of filament lamps, said unit incorporating memory means for storing at least one value of current or power associated with the operation of said filament lamps.

Preferred embodiments of the present invention will now be described with reference to accompanying drawings wherein:

Figure 1 shows one embodiment of switching circuit according to the present invention; and

Figure 2 shows a preferred embodiment of switching circuit according to the present invention.

The switching circuit of figure 1 incorporates a regulated power supply (not shown). The power supply includes a voltage reference source (eg. 4V) connected to one input of comparator 10. Comparator 10 drives transistor 11 between cut off and saturation. When saturated transistor 11 charges capacitor 12. When capacitor 12 is charged to the reference voltage, transistor 11 is driven to cut off via comparator 10.

The switching circuit of figure 1 includes memory means 13 for storing a value of current as measured across current sense resistor R. Memory means 13 comprises an 8 bit electrically erasable memory. A memory reset button may be pressed when it is desired to reprogram memory 13. Current is derived via differential amplifier 14 connected across resistor R.

The switching circuit of figure 1 may alternatively be adapted for storing values or power instead of current. To this end a multiplying circuit may be added at the output of amplifier 14 for multiplying the measured curr nt and operating voltage (B+) for calculating power.

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The switching circuit of figure 1 includes timer means 15. Under normal operating conditions timer means 15 is adapted to generate output pulses at approximately 1.5HZ and having a 60/40 duty cycle.

Comparator 16 is adapted to continuously monitor real current (or power) usage and to compare this with the value stored in memory 13. When real and stored values of current (or power) differ by more than, say 5% comparator 16 may trigger and adjust the frequency of timer 15. Preferably the frequency of timer 15 is doubled to approximately 3HZ to indicate outage.

The switching circuit of figure 1 includes a twin coil latching relay 17. The "on" coil of latching relay 17 is driven by transistor 18 and logic circuit 1. The "off" coil of relay 17 is driven by transistor 19 and logic circuit 2.

Logic circuit 1 is arranged such that its output D is high when input B is high and input C is low (D=B.C). Logic circuit 2 is arranged such that its output E is high when input A is high and input C is high (E=A.C). It will be appreciated that C is high when the relay contacts are closed and low when open.

With the relay contacts open (C low) and output B of time 15 goes high, transistor 18 switches and applies power to the "on" coil of latching relay 17 closing the relay contacts. C goes high and power is subsequently removed from the "on" coil of relay 17.

Meanwhile output A (complement of B) is low hence transistor 19 remains off. It may be seen that the relay contacts will stay closed as long as B remains high.

In one form the output B of timer 15 may be 40% high and 60% low.

When output A of timer 15 goes high and the relay contacts are closed (C high) transistor 19 switches and applies power to the "off" coil of relay 17 opening the relay contacts. C goes low and power is removed from the "off" coil of relay 17.

Meanwhile output B (complement of A) is low hence transistor 18 remains off. The relay contacts will stay open as long as output A remains high. Consistent with the above

output A of timer 15 may be 40% low and 60% high.

Flash rate indication may be via chime generator 20 and piezo element 21. Generator 20 preferably has a decaying chime characteristic. The chime generator 20 and piezo element 21 may produce an output each time that the contacts are open.

Figure 2 shows one embodiment of the preferred microprocessor based implementation of switching circuit according to the present invention. The switching circuit connections are B+ (positive) and 40 (negative). Connection 40 forms the common or ground connection locally within the switching circuit.

The switching circuit of figure 2 includes a voltage regulator 22. The voltage regulator 22 supplies the requisite steady and safe voltage to the microprocessor 23 and other components as necessary. Regulator output V1 is available only when the turn indicator or hazard lights are turned on and load switch T3 is "off". Output V1 can supply a relatively large amount of power for the A to D converter function in microprocessor 23 (fully powered via V1) and piezo speaker 24.

Transistor T1, in conjunction with resistors R1, R2, R3 and transistor T2, allow energy storage capacitor C1 to be charged to a steady safe voltage to power the "on" timer function in microprocessor 23 and load switch T3. Load switch T3 comprises a MOSFET transistor. This configuration, or like means, ensures that capacitor C1 is fully and adequately charged during the "off" period of load switch T3 to supply energy for the effectively unpowered "on" period when the indicator lamps are energised.

The presence of regulator output voltages V1 and V2, signals to microprocessor 23, that the switching circuit has been energised and should commence sequencing.

At this time, after V1 and V2 have risen to their correct values, microprocessor 23, turns load switch T3 "on" via gate drive 33, and ensures sampling switch S2 is connected. Capacitor C2 "stores" a representation of the indicator lamps' load current as sensed by load current sense resistor Rcs. To enable a practical and sufficient voltage to

be s nsed by A to D input 26 of microprocessor 23 prescaling amplifier 27 is employed. Load current can also b sensed directly from an alternative implementation to th MOSFET switching device (T3).

During the initial "on" period, multiplexing switches S5, S3 and S4 are held open circuit by respective controlling inputs 28, 29 and 30 of microprocessor 23. These multiplexing switches may be integrated with microprocessor 23. Overload sense means 31 also may be integrated with microprocessor 23.

During the "on" period of the switching circuit overload sense means 31 may be activated. Overload means 31 may comprise a relatively high speed voltage comparator. If too much current flows through the load switch T3 sufficient voltage may be developed across T3 to readily operate such a comparator and indicate the overload to microprocessor 23 via 32 (or directly), which in turn may switch "off" load switch T3.

Microprocessor 23 may attempt to turn the load switch T3, "on" again. Hysterysis may be built into over-current comparator 31 to enable the unit to operate successfully in most cases. A true wiring short circuit may be accommodated by normal fusing means already installed as a normal part of the vehicle's indicator lamp system.

Immediately prior to turning "off" load switch T3, load current sampling capacitor C2 is left "floating" or isolated, to be read later in the "off" cycle by the A to D converter.

In normal operation, as microprocessor 23 turns "off" load switch T3 via 33, open supply voltage can be read by actuating A to D multiplexing switch S5. Resistors R4 and R5 scale the supply voltage to a level comfortably readable by the A to D converter within microprocessor 23.

Before the supply voltage is read switch S4 is operated via 30 and prescaling amplifier 27 and A to D converter accurately "zeroed". Once the system is zeroed (via switch S4) supply voltag can be read (via switch S5).

During this period immediat ly following the end of the "on" period, the piezo loudspeaker 24 can be actuated via

34 and the audible flasher annunciation tones sounded. Microprocessor 23 preferably performs this task concurrently with appropriate A to D conversion processes as described.

To make a flasher unit incorporating the switching circuit of the present invention sound similar to the normal perception of a flasher unit, the piezo speaker may be arranged to sound immediately prior to the "on" period. In this way, MOSFET load switching means T3 which is entirely silent, may be perceptibly associated with more commonly existing flasher units.

Once microprocessor 23 has zeroed and read the supply voltage, load current can be read by the A to D converter of microprocessor 23 (after closing multiplexing switch S3). Microprocessor 23 compares the load current with the last stored value of averaged and normalised load current from non-volatile memory 35. During comparison microprocessor 23 performs the testing algorithms described earlier. If need be, an updated averaged and normalised current value can be written into non-volatile memory 35, during the "off" period.

After the appropriate "off" time period (selected according to "outage" indication, "learn" mode, or normal mode) piezo loudspeaker 24 sounds immediately prior to load switch T3 closing for the "on" period. This cycle repeats as long as power is applied. Sufficient means may be programmed within microprocessor 23 to ensure acceptable operation should the switch of the vehicle's turning indicators be turned "off" in any part of a cycle.

Microprocessor 23 could be replaced by any equivalent means eg. a state machine.

In the event that a latching relay, or partially latching relay is employed as the load switching means, differences to the operation cf the implementation described above include a current pulse to turn the latching relay "off". This is a small alteration well within the capacity of persons skilled in the art and is not described for reasons of brevity.

Typical flasher units have two or three terminals. These terminals may be connected as follows:-

1. Battery positive via the ignition switch.

2. Load (th_ indicator lamps) via the vehicle's turn indicator switch. Note, the other side of the load is connected to the negative (commonly ground) side of the battery.

3. The third terminal (if provided) is used in two ways:

a) As a connection to the pilot light and an auxiliary contact in the flasher unit.

b) As a reference or system ground (negative terminal to the battery). This connection is used by less sophisticated electronic flasher units.

The switching circuit of the present invention may be adapted to operate with any of these configurations.

A flasher unit incorporating a switching circuit according to the present invention may be engineered to suit a wide range of operating parameters and conditions. The following may be typical:

SIZE:

The flasher unit of the present invention preferably is small enough to ensure that it can be installed in any desired vehicle.

ADAPTING BASE:

Different base plug sub-assemblies may be used to enable the flasher unit to be fitted to various vehicles. This may be necessary because different connector tab arrangements and positions may be in use.

TEMPERATURE RANGE:

The switching circuit preferably operates with ambient temperatures from -35 to +65C and can withstand storage temperatures from -40 to +80C.

SUPPLY VOLTAGE:

Operating voltage range may be from 4.5 to 32 volts DC. The flasher unit preferably is capable of withstanding transient voltages commonly encountered in automotive electrical systems.

VOLTAGE DROP:

The flasher unit will have full supply voltage across its switching terminals while the load

switching means is "off" or open-circuit and a relatively small voltag across its switching terminals while the load switching means is "on". The maximum voltage drop preferably is 0.4 volts across the flasher unit whilst conducting the rated maximum steady state load current (measured in normal operating ambient temperature, 24 deg. C).

MAXIMUM SWITCHING CURRENT (steady state):

This may be approximately 17 amps at 13.8 volts or 10 amperes at 28.4 volts.

FLASH RATE:

Preferably is able to be set between wide limits, but the selected value is expected to be between 60 and 120 flashes per minute with a duty cycle 40% to 60% "on" time. The finally selected flash rate may be stable within 10% of the selected nominal value (say 100 flashes per minute) over the allowable operating conditions. Flash rate may double for lamp failure indication.

LAMP FAILURE DETECTION THRESHOLD:

Lamp failure ("outage") indication may occur when power supplied to the flasher unit's load, preferably averaged over two or more successive "flash" indications, is sensed as having dropped by 10 to 30 watts.

AUDIBLE SIGNAL:

To sound a distinctive click, chime or other appropriate sound synchronised with load switching. The audible signal volume preferably is adjustable during the flasher unit's installation into the vehicle.

It will be appreciated that various alteration, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A switching circuit for switching lectrical power to a load, said circuit comprising:

load switching means for conducting said power to said load upon actuation;

timing means for intermittently actuating said load switching means;

measuring means for measuring a value of electrical current associated with said power;

memory means for storing at least one said value of electrical current;

comparator means for comparing said stored value of current with said measured value; and

means for indicating whenever said stored value of current differs from said measured value by a predetermined amount.

2. A switching circuit according to claim 1 wherein said stored value comprises an averaged or normalized representation of said value of electrical current.

3. A switching circuit according to claim 2 wherein said averaged or normalized representation of said value of electrical current is calculated by reference to the voltage associated with said power.

4. A switching circuit according to claim 1, 2 or 3 wherein said stored value is replaced with said measured value whenever said measured value differs from said stored value by an amount other than said predetermined amount.

5. A switching circuit according to any one of the preceding claims wherein said load comprises a plurality of filament lamps and wherein said predetermined amount corresponds to values of current which would be drawn by 0.5 to 1.5 filament lamps.

6. A switching circuit according to any one of the preceding claims wherein said load switching means comprises a MOSFET device.

7. A switching circuit according to any one of claims 1-5 wherein said load switching means comprises a relay.

8. A switching circuit according to any one of the preceding claims wherein said timing means is adapted to

actuate said load switching m ans between 60 and 120 times per minute.

9. A switching circuit according to any one of the preceding claims wherein said timing means is adapted to actuate said load switching means with a duty cycle between 40 and 60 per cent "on" time.

10. A switching circuit according to any one of the preceding claims wherein said means for indicating includes means for adjusting said timing means such that said load actuating means is actuated at twice the usual rate.

11. A switching circuit according to any one of the preceding claims including means for cancelling said indicating means.

12. A switching circuit according to any one of the preceding claims wherein said measuring means includes an analogue to digital converter.

13. A switching circuit according to any one of the preceding claims wherein said memory means is non-volatile.

14. A switching circuit according to any one of the preceding claims wherein said memory means comprises an Electrically Erasable Programmable Read Only Memory.

15. A switching circuit according to any one of the preceding claims including audible signal generator means for generating an audible sound synchronized with said load switching means.

16. A switching circuit according to any one of the preceding claims including processing means for providing some or all of the functions of said timing means, comparator means, measuring means and said audible signal generator means.

17. A switching circuit according to claim 16 wherein said processing means comprises a microprocessor or microcontroller.

18. A switching circuit according to claim 17 wherein said microprocessor or microcontroller comprises a custom or semi-custom device.

19. A switching circuit according to claim 1 substantially as h rein described with reference to Figure 1 or 2 of the accompanying drawings.

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20. An automotive flasher unit incorporating a switching circuit according to any one of the preceding claims.

21. An automotive flasher unit for intermittently switching electrical power to a plurality of filament lamps, said unit incorporating memory means for storing at least one value of current or power associated with the operation of said filament lamps.

22. A flasher unit according to claim 21 incorporating means for updating said stored value of current and/or power.

23. A flasher unit according to claim 22 wherein said stored value is updated whenever said stored value differs from the value of current or power associated with said operation of said filament lamps by a predetermined amount.

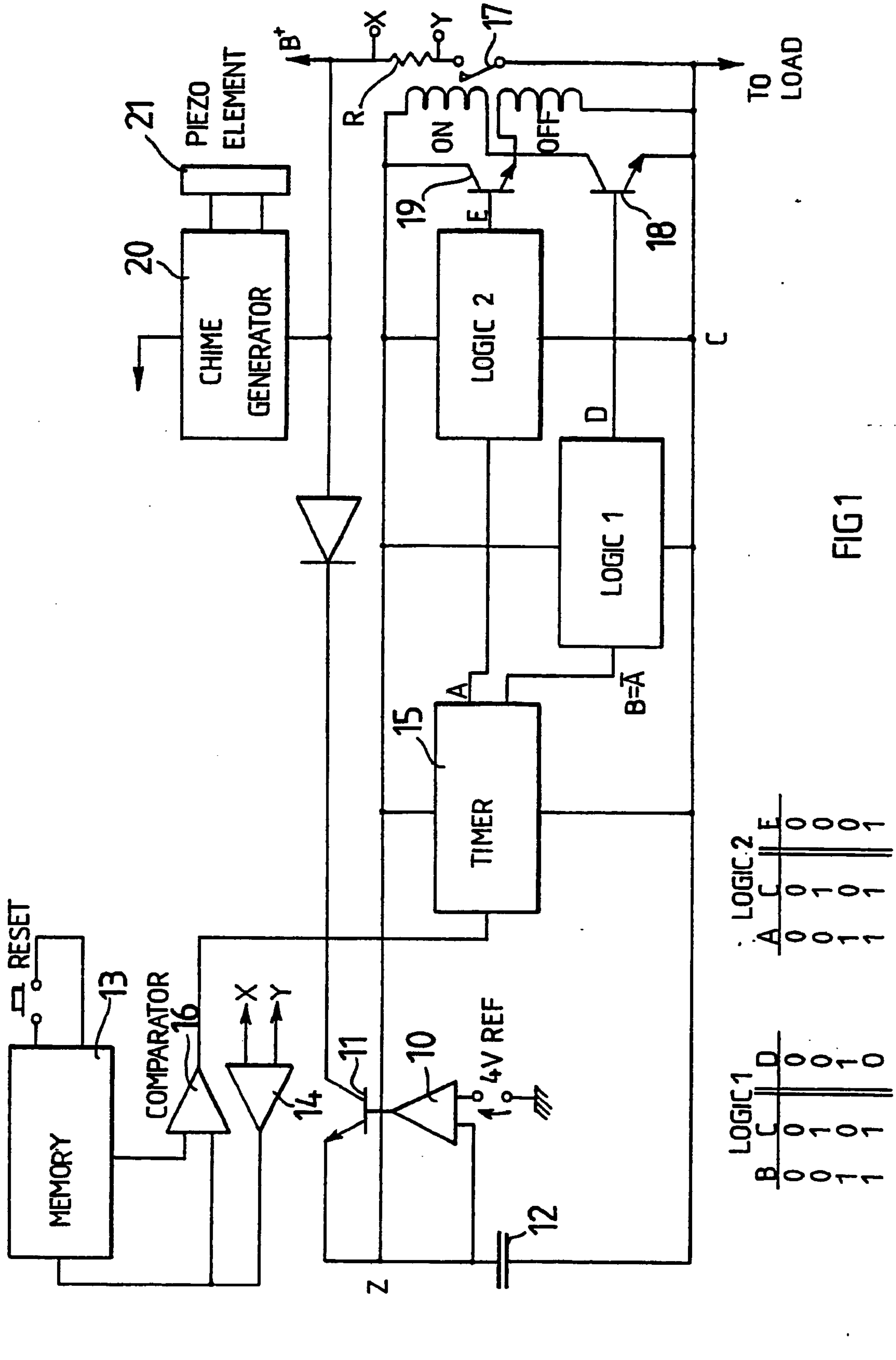
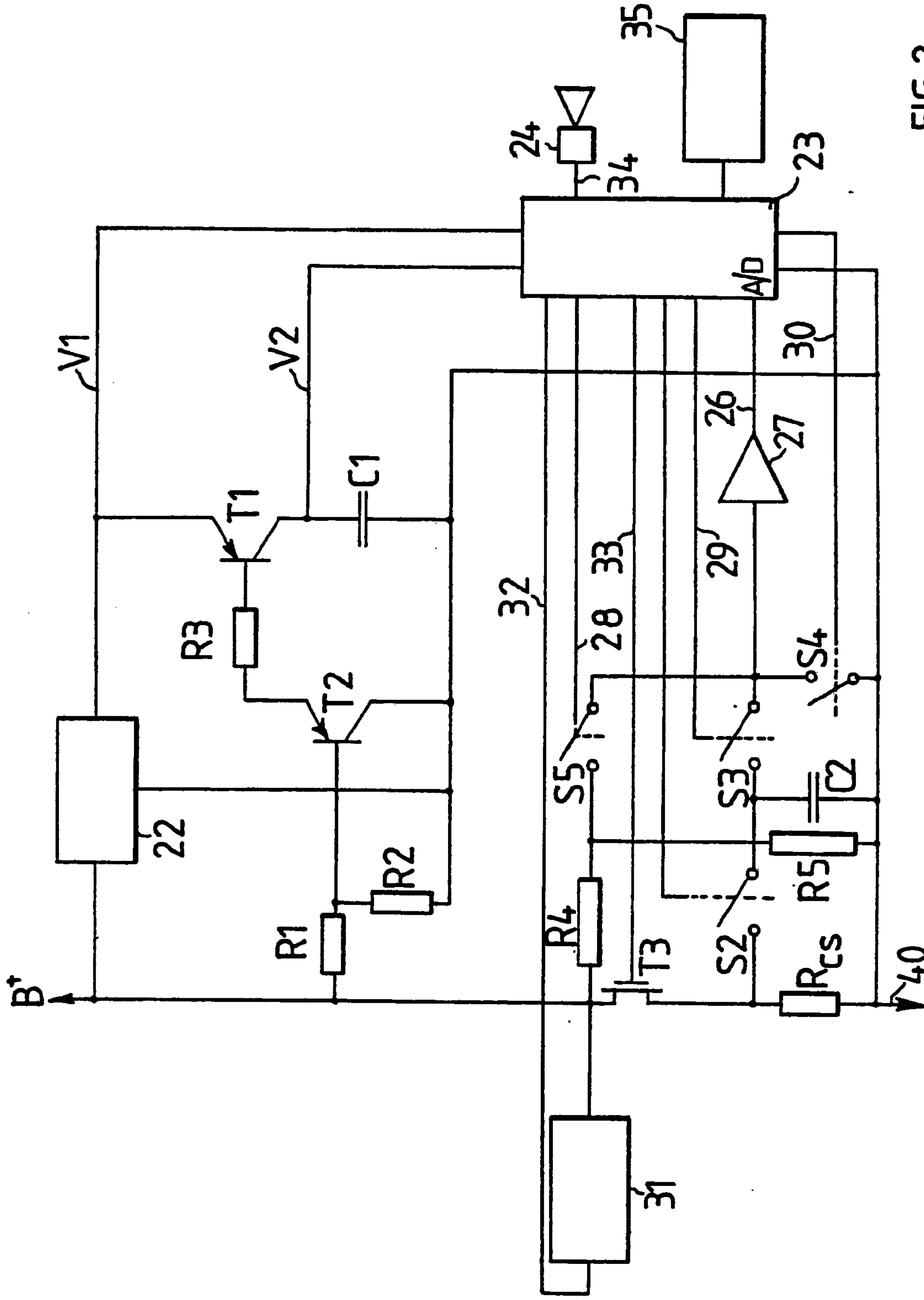

B+
X
Y
17
R
TO LOAD
PIEZO ELEMENT
21
20
CHIME GENERATOR
ON
OFF
19
18
E
LOGIC 2
C
D
LOGIC 1
A
B=Ā
15
TIMER
RESET
13
MEMORY
COMPARATOR
16
X
Y
14
11
10
4V REF
12
Z
LOGIC 1
B C D
0 0 0
0 1 0
1 0 1
1 1 0
LOGIC 2
A C E
0 0 0
0 1 0
1 0 0
1 1 1

FIG1


B+
V1
V2
T1
T2
C1
R1
R2
R3
R4
R5
RCS
T3
C2
S2
S3
S4
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A/D

FIG 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/AU 86/00380

I. CLASSIFICATI N F SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] B60Q 1/34, 1/38

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	B60Q 1/34, 1/38

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

AU : IPC as above; Australian Classification 94.9, 95.7

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US,A, 4213116 (HOLTZMAN) 15 July 1980 (15.07.80) See column 2 lines 29-41	(21)
A	US,A, 4349810 KUGO et al) 14 September 1982 (14.09.82)	
A	US,A, 4207553 (MIZUNO et al) 10 June 1980 (10.06.80)	
A	US,A, 3955174 (IVES et al) 4 May 1976 (04.05.76)	
A	GB,A, 2087175 (THOMAS ELECTRONICS LIMITED) 19 May 1982 (19.05.82)	
A	FR,A, 2446047 (GALEA et al) 1 August 1980 (01.08.80)	
A	EP,A, 14537 (NIPPON DENSO CO., LTD) 20 August 1980 (20.08.80)	
A	EP,A, 44187 (BRITAX (P.M.G.) LIMITED) 20 January 1982 (20.01.82)	
A	AU,B, 41802/78 (523210) (NIPPONDENSO CO., LTD) 7 June 1979 (07.06.79)	
A	SU,A, 1054142 (MOLI) 15 November 1983 (15.11.83) (Derwent English Language Abstract Q16 84-181567/29)	
A	JP,A2, 55-145035 (NIPPON DENKI K.K.) 12 November 1980 (12.11.80) (JAPATIC English Language Abstract)	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11 March 1987 (11.03.87)	26·3·87 (26-MARCH-1987)
International Searching Authority	**Signature of Authorized Officer**
Australian Patent Office	M.E. DIXON

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 86/00380

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
US 4213116	DE 3001469 JP 55110635	FR 2446742	GB 2040613
US 4349810	DE 3014417	GB 2047489	JP 55140622
US 4207553	JP 53080998		
US 3955174	DE 2320541 IT 984310	ES 413878 JP 49020591	GB 1436112
EP 14537	JP 55106832	US 4259659	
AU 41802/78	EP 2359	JP 54077097	US 4236143

END OF ANNEX